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**From:** G D Beckett [g.d.beckett@aquiver.com]  
**Sent:** 1/12/2018 4:25:42 PM  
**To:** Whittier, Robert [Robert.Whittier@doh.hawaii.gov]; G D Beckett [g.d.beckett@aquiver.com]; Matt Tonkin [matt@sspa.com]; Grange, Gabrielle Fenix [Gabrielle.Grange@doh.hawaii.gov]; TU, LYNDSEY [Tu.Lyndsey@epa.gov]; Ichinotsubo, Lene K [lene.ichinotsubo@doh.hawaii.gov]  
**CC:** Takaba, Richard R [richard.takaba@doh.hawaii.gov]; roxanne.kwan@doh.hawaii.gov; joanna.seto@doh.hawaii.gov  
**Subject:** Re: Local Area Geology - Possible Approach  
**Attachments:** Factured\_NAPL2.png

Thanks Bob. I've been thumbing through various materials trying to nail the core issues regarding the nature of NAPL transport vs. the simple sponge/volume approach taken by Chuck Newall. It's probably going to take a bit to pull it all together, if that's useful, but here is another picture of NAPL movement in a fractured system. Because this is a "real" system, it does a much better job of showing the complexity of NAPL movement; highly heterogeneous and non-predictable from a deterministic point of view. Further, and more to follow, I have no expectation that the clinker zones responds to transport as a uniform block. I'd rather expect that there is a highly variable pore network and that NAPL will find paths of least resistance and flow predominantly within those. There will be retention of the NAPL along those flow paths, but it will be a miniscule fraction of the type Chuck claims. I'm looking again for more help from you & Don, along with the rest of the team.

There are other problems with the approach. Fundamentally, it is the CONCAWE (mid-80s) approach parsed for multiple bedding planes. That approach, while heuristically informative at times, has been shown to be totally non-representative of actual subsurface NAPL flow and risk. Bluntly, NAPL moves more quickly and unpredictably than most heuristic models suggest (including some I have authored for the API). One of the NAPL experts in the room was silent, which was interesting. Sorab Panday, along with YuShu Wu & Peter Huyakorn developed the MAGNAS3 multiphase model, one that I often use for numerical simulation of NAPL flow. He knows most certainly about the limitations of Chuck's approach.

Best regards

-----Original Message-----

**From:** Whittier, Robert [mailto:Robert.Whittier@doh.hawaii.gov]  
**Sent:** Friday, January 12, 2018 09:14 AM  
**To:** 'G D Beckett', 'Matt Tonkin', 'Grange, Gabrielle Fenix', 'TU, LYNDSEY', 'Ichinotsubo, Lene K'  
**Cc:** 'Takaba, Richard R', 'Kwan, Roxanne S', 'Seto, Joanna L'  
**Subject:** Re: Local Area Geology - Possible Approach

GD,

I think our general consensus coincides with yours, that there are some issues with Chuck's approach and calculations. Will try to get my thoughts together this weekend.

Thanks,  
Bob W

**From:** G D Beckett <g.d.beckett@aquiver.com>

**Sent:** Thursday, January 11, 2018 4:01 PM

**To:** Matt Tonkin; Whittier, Robert; G D Beckett; Grange, Gabrielle Fenix; TU, LYNDSEY; Ichinotsubo, Lene K

**Cc:** Takaba, Richard R; Kwan, Roxanne S; Seto, Joanna L

**Subject:** Re: Local Area Geology - Possible Approach

Folks,

Just for some simple context, attached is Chuck Newall's graphic in his EPA paper for his conceptualization of fractured NAPL systems. Does this resemble what we heard? The oversimplification is both erroneous and non-conservative (from my perspective).

Best regards.

-----Original Message-----

**From:** Matt Tonkin [mailto:matt@sspa.com]

**Sent:** Thursday, January 11, 2018 10:14 AM

**To:** 'Whittier, Robert', 'G D Beckett', 'Grange, Gabrielle Fenix', 'TU, LYNDSEY', 'Ichinotsubo, Lene K'

**Cc:** 'Takaba, Richard R', 'Kwan, Roxanne S', 'Seto, Joanna L'

**Subject:** Re: Local Area Geology - Possible Approach

Thanks Bob. It seems we should discuss this on a call together perhaps to get down to details. The evs materials we have may represent one possibility based on certain perhaps default kriging options: we have the geologic points in Groundwater desktop and if it makes sense to incorporate a different dip/strike into the interpolation to obtain surfaces that better comport with the CSM that's readily doable. But again - sounds like something to speak about on a call.

Matthew J. Tonkin

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**From:** Whittier, Robert <Robert.Whittier@doh.hawaii.gov>

**Sent:** Thursday, January 11, 2018 7:05:29 AM

**To:** Matt Tonkin; G D Beckett; Grange, Gabrielle Fenix; TU, LYNDSEY; Ichinotsubo, Lene K

**Cc:** Takaba, Richard R; Kwan, Roxanne S; Seto, Joanna L

**Subject:** Re: Local Area Geology - Possible Approach

Hi GD, Matt, and All,

I have pretty high confidence that AMEC did a good job converting the barrel logs to EVS. That said we have the barrel logs and can do some QA. AECOM has similar visualizations. One of you mentioned running slices through the 3d rock column. In the data set is an AVI file that does just that. Just looking quickly at that video I would conclude the dip direction of the lava bedding is aligned down the axis of the tank farm. I believe knowing the direction and magnitude of the dip is extremely important. Back to the AVI file, the implied direction of dip is much different than what AECOM has concluded. I don't think the boreholes are closely enough spaced to connect lava flows with confidence, so the only tools we have are the barrel logs and exposures on the flanks of the Red Hill Ridge. I have done some cursory looking and it appears that we can track lava flows over a significant distance on the Moanalua side of the Red Hill Ridge, but due heavy

growth and access, the Halawa side of Red Hill Ridge would be more difficult. Another line of evidence, and I haven't looked at it in detail yet, would be orientation of the Red Hill Shaft infiltration tunnel. According to AECOM's testimony, the flow into infiltration gallery is at the upper end after the bend. It would seem logical that during construction, the bend was to follow a clinker zone and would thus represent the strike, making the direction of dip perpendicular to the orientation of the upper end of the infiltration gallery.

AECOM has stated a dip direction, but has not detailed how they arrived at their conclusion. More happy to ask the question. But at this point have not done sufficient homework to determine whether or not their conclusions are valid.

Thanks,  
Bob W.

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**From:** Matt Tonkin <matt@sspa.com>  
**Sent:** Thursday, January 11, 2018 6:19 AM  
**To:** G D Beckett; Grange, Gabrielle Fenix; Whittier, Robert; TU, LYNDSEY; Ichinotsubo, Lene K  
**Cc:** Takaba, Richard R; Kwan, Roxanne S; Seto, Joanna L  
**Subject:** Re: Local Area Geology - Possible Approach

GD:

What you outline is very similar to my line of thinking toward the end of the meeting yesterday. At least for the time being this is likely the most readily accessible high resolution stratigraphic data we have and though it may be dated etc it would very likely quite quickly facilitate the sort of analyses you describe. I can today quickly look to see if the raw evs files (likely they are UCD or eff format) can be used to support this without needing anything else.

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**From:** G D Beckett <g.d.beckett@aquiver.com>  
**Sent:** Thursday, January 11, 2018 6:06:09 AM  
**To:** Matt Tonkin; G D Beckett; Grange, Gabrielle Fenix; Whittier, Robert; TU, LYNDSEY; Ichinotsubo, Lene K  
**Cc:** Takaba, Richard R; Kwan, Roxanne S; Seto, Joanna L  
**Subject:** Local Area Geology - Possible Approach

Good morning folks,

This note is mostly for Bob & Don, but thought others might have interest given our discussions yesterday. As I'll likely continue to say "*I didn't realize until..*" and "*before I forget..*" Don & Bob pointed out the underlying data quality of the geology animation, so we may already have a great start on the local area system in and around the RH tank farm. As a followup Bob & Don: Is that rendering accurate and representative within the available data and original excavation logging and does it account for all available data points? Second, if we trust it is a good rendering, one would hope that the bedding layers in-between

the clinker zones are also characterized in the EVS or other data files, do we know whether that has been done?

I guess my thought is even if this tank-area geologic rendering is not perfect, it is probably as good a starting point as any for consideration of how fuel releases might migrate within this system. Serious omissions or gaps, such as we saw in the contaminant renderings, might cause us pause in suggesting that use for this geologic block. Don, this may save you & your logging expert some time & effort, and we would be able to more quickly come to some initial understanding of the LNAPL transport scenarios if we trust this geologic interpretation.

If the geologic column is trustworthy, here is my suggestion: Matt uses EVS. We could together (the rock head group), look at several slices through the tank farm area and define a few that range from likely best to worst-case in terms of LNAPL migration. Best case would be limited continuity of clinker zones beneath a release point with shallow dips; worst-case would be the opposite end of the spectrum. From there, we could ask the Navy to use those as the starting point for evaluating LNAPL migration and the "source" term for the groundwater model. Alternatively or in concert, I could set up some cross-sectional multiphase numerical domains to ask the same so we have some idea of impact outcome ranges. Of course, as discussed, the outcomes will be a function of the release scenarios executed, in turn dependent on failure mechanics and the construction setting of the tanks (MIA from the Navy right now, far as I know).

Best regards.

**G.D. Beckett, RG, CHg**  
*Principal Hydrogeologist*

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